National Aeronautics and Space Administration

NASA Case Study

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Lifting NOAA-N PRIME

A Tale of Two Carts

Near the end of the summer of 2003, NOAA-N and NOAA-N PRIME, the last Television Infrared Observational Satellite (TIROS) design spacecraft, were in final testing at the contractor's assembly facility in California. The TIROS program, managed by the Goddard Space Flight Center (GSFC), shared space at the facility with the Defense Meteorological Satellite Program (DMSP). The shared space included the use of some common GSE (Ground Support Equipment). Turn Over Carts (TOCs) used by NOAA-TIROS (both NOAA-N and N-Prime), and the DMSP, are stored at the facility. (TOCs are large, hydraulically controlled tables to which a satellite can be bolted and held in various positions for the purpose of performing work on the satellite.) Specifically, they were kept in a room between the two large bays where the various spacecraft were being assembled.

The DMSP TOC was red-tagged for a repair problem. Therefore the DMSP team decided to configure and use the TIROS TOC instead. Sharing equipment is common and informal among programs, and it is the users' responsibility to assure proper TOC configuration before each use.

To prepare the TOC, the DMSP team had to remove the adapter plate that is used to mate the TIROS satellites to the cart. This was because the team had to use a different adapter plate for the DMSP satellite. So they removed the 24 bolts that hold the plate to the cart. However, as they finished this process, they noticed that the TIROS cart also had a red tag, meaning it too was in need of repair. Fixing the DMSP cart would actually have been easier than repairing the TIROS cart. They left the TIROS TOC with the adapter ring sitting on top of it, and went back to their own TOC.

STOP AND THINK: What is your responsibility when working on space hardware?

A Schedule Opening

On September 3, 2003, management decided to take advantage of an opening in the schedule between NOAA-N and N-Prime. This would allow the mechanical team to "shim" N-PRIME's microwave humidity sounder instrument (MHS). This procedure called for removing and replacing the instrument with the help of a TOC that would hold the satellite in a horizontal position. The shimming activity was scheduled to take place on Saturday, September 6.

The procedural documents for the MHS removal were quickly assembled, the first call for mechanical technician support having been made on Thursday, September 4. On Friday, September 5, an all-hands meeting was held at the facility to reiterate company policy for work on flight spacecraft.

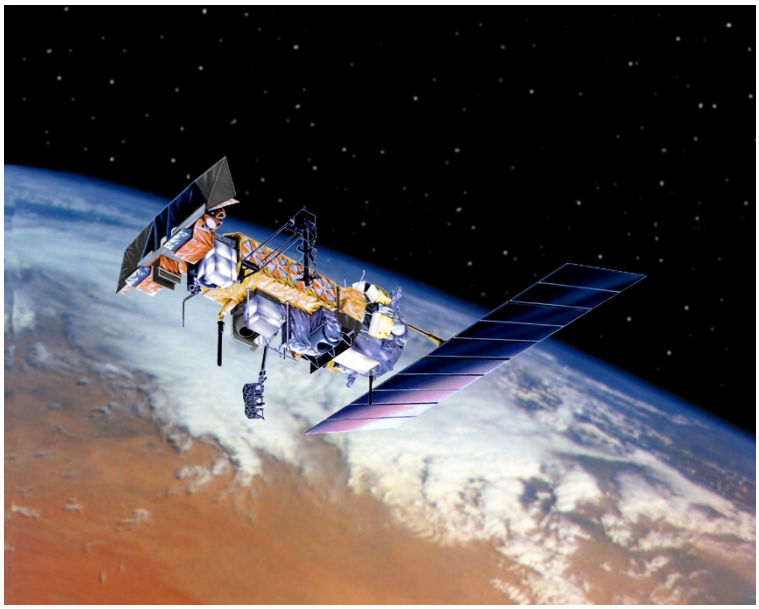


Figure 1 - Artist's conception of NOAA-N Prime in orbit

On Friday afternoon, after a disagreement with the responsible technical engineer (RTE) over the last-minute preparations and lateness of some paperwork, the most experienced lead technician declined to participate (Saturday work was optional). While the assembled crew had experience maneuvering space flight hardware, some members were assigned tasks outside their primary area of expertise. Still, Integration and Testing (I&T) operations had commonly been performed on Saturdays for years. The project office had even encouraged taking advantage of schedule openings such as this for efficient workforce management.

The planned operation consisted of the following:

1. Preparing the TOC that had been used recently for a NOAA-N spacecraft operation, but subsequently stored in a support equipment storage area common to two programs
2. Preparing the NOAA N-PRIME spacecraft for installation on the TIROS TOC
3. Lifting the spacecraft onto the TOC, and securing its conical payload (booster) adapter to the TIROS adapter plate
4. Rotating the TOC with the spacecraft attached to the horizontal position
5. Finally, removing and replacing the MHS instrument

STOP AND THINK: As a junior technician you are somewhat uncomfortable after the lead technician left. Everyone else seems to be OK. What questions are you asking yourself?

24 Empty Bolt Holes

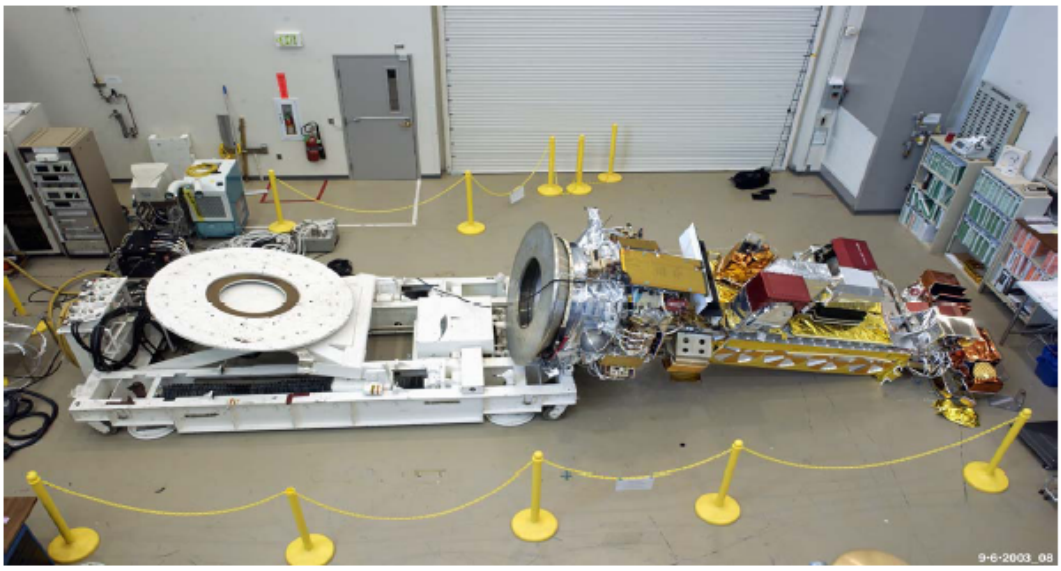
Step by step, the operation involved configuring the spacecraft and TOC, installing the spacecraft on the TOC, and tilting the spacecraft to the horizontal position. After that, once the spacecraft was horizontal, the MHS Instrument would be removed, shimmed, and reinstalled.

It was early Saturday morning on September 6. A Product Quality Control rep arrived at 6:42 A.M., and signed off that the TOC was properly configured for the operation. He did so--on the basis of the TOC log, knowledge of a recent use of the cart, and his trust of the RTE and technicians--but without a visual inspection. At approximately 6:45 A.M., the TIROS team positioned its cart under NOAA-N PRIME, and began to attach the spacecraft to the adapter plate on the TOC.

During this bolting process, a technician noticed that there were some empty bolt holes in the adapter ring. He pointed out this fact to the RTE. The RTE--knowing that the adapter plate had 88 holes for mounting spacecraft, and that only 44 were used to mount the TIROS satellite--responded that it was fine: some extra empty holes were normal. The TIROS team had now bolted the TIROS NOAA N-Prime satellite to the adapter plate, which was merely resting on the TOC as the DMSP team had left it. The team continued with the lifting procedure.

At 7:28 A.M., as the satellite was being tilted, it slid off the cart because the adapter plate was not bolted to the cart. No one was injured, but the satellite sustained heavy damage.

STOP AND THINK: Why did this accident happen? Could you have helped prevent it?



Figure

The details describe
of the events leading
the Mishap Investig
URL: http://www.na

Eventually, NOAA N-PRIME was rebuilt, successfully launched, and placed into orbit in February 2009.

For more information on NOAA N-PRIME (now NOAA 19), see the project website at: http://www.nasa.gov/mission_pages/NOAA-N-Prime/main/index.html.

Background on NOAA-N PRIME and the GOES-POES Program

The Geostationary Operational Environmental Satellites (GOES), in combination with the Polar Operational Environmental Satellites (POES), are critical to U.S. National Weather Service missions. Such missions operate under the National Oceanographic and Atmospheric Administration (NOAA). The GOES-POES system had evolved since 1974 into the basic element of U.S. weather monitoring and forecasting.

The GOES-POES mission comprised two geostationary satellites and two polar-orbiting satellites operating in pairs. GOES-East covered the U.S. East Coast and GOES-West covered the West Coast. GOES provided real-time weather data for short-term weather forecasting (namely, warnings of severe weather) and space environment monitoring, as well as research and development. POES primarily provided long-range forecasting, offering infrared and non-visible data for any region of the Earth that was no more than six hours old.

Figure 3 - Successful NOAA N-Prime Launch from Vandenberg on Feb. 6, 2009

POES was a cooperative effort between NASA, NOAA, the UK, and France. GSFC was responsible for the construction, integration, and launch of NOAA satellites. Operational control of the spacecraft was turned over to NOAA after a satellite checked out on orbit, normally 21 days after launch.

The NOAA satellites carried seven scientific instruments and two for search and rescue. (Data from the latter had initiated tens of thousands of rescues over the years.)

The polar-orbiting platform was designed to support:

1. Environmental monitoring instruments for imaging and measuring the Earth's atmosphere, its surface, and cloud cover, including Earth radiation, atmospheric ozone, aerosol distribution, sea surface temperature, and vertical temperature and water profiles in the troposphere and stratosphere
2. Measurement of proton and electron flux at orbit altitude
3. Data collection from remote platforms
4. The search and rescue satellite-aided tracking (SARSAT) system